ARJUNA

JEE

Test Ka syllabus ⇒ Complete mole Concept

(1) Mole

(1) E.F & M.F.

(1)+(1) Concentration

(2) Stiochoimetry

(1) L.R.

(1) Avg. At. wt & M. wt

LECTURE - 04

Atomic structure

Sarvesh sir

TABLE OF CONTENT

01 Planks quantum theory

02 photo electric effect

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plank's Quantum theory (particle nature of light

① suppose → light → small energy packets travell Krti hai
↓
quanta → incase of light = photon

② photon → $E \propto \nu$

$$E = h\nu = \frac{hc}{\lambda}$$

where → h = plank's const

$h = 6.626 \times 10^{-34}$ Joulesec.

$c = 3 \times 10^{8} \frac{m}{sec}$

λ = wavelength of light

(3) any photon → $E = n \times E_{min}$.

$E = n \times h\nu$

$n = 1, 2, 3, 4$ - - - - - -

$n \neq 0$

$n \neq$ fractional

$n \neq$ Negative

$E_{min} = x$ Joule

possible energy of phon

$2x$ → ✓

$\frac{2}{3}x$ → (X)

λ**

→ $1\,nm = 10^{-9}\,m = 10^{-7}\,cm$

→ $1\,pm = 10^{-12}\,m = 10^{-10}\,cm$

→ $1\,A^{0} = 10^{-10}\,m = 10^{-8}\,cm$

→

Q. Calculate the energy in joule corresponding to light of wavelength 45 nm (Planck's constant, $h = 6.63 \times 10^{-34}$ Js; speed of light $c = 3 \times 10^{8}\ ms^{-1}$)

A. 6.67×10^{15}

B. 6.67×10^{11}

C. 4.42×10^{-15}

D. 4.42×10^{-18} ✓

$\lambda = 45\ nm = 45 \times 10^{-9}\ m$

$E = \frac{hc}{\lambda} = \frac{6.6 \times 10^{-34}\ \text{Joule sec} \times 3 \times 10^{8}\ \text{m/sec}}{45 \times 10^{-9}\ m}$

$= 0.44 \times 10^{-17}$ Joule

$= 4.4 \times 10^{-18}$ Joule

Q. The energies E_1 and E_2 of two radiations are 25 eV and 50 eV respectively. The relation between their wavelengths, i.e., L_1 and L_2 will be

40 sec

A $L1 = 2L2$

B $L1 = 4L2$

C $L1 = ½ L2$

D $L1=L2$

$C_{SD}=6$

$\Rightarrow 1\,eV = 1.6 \times 10^{-19}$ Joule

$E = \frac{hc}{\lambda} \Rightarrow E \propto \frac{1}{\lambda}$, $E = h\nu$, $E \propto \nu$

photon → 1 $E_1 = 25\,eV$

photon − $E_2 = 50\,eV$

$E_1 = \frac{hc}{L_1}$ — (I)

$E_2 = \frac{hc}{L_2}$ — (II)

$\frac{E_1}{E_2} = \frac{L_2}{L_1}$

$\frac{25}{50} = \frac{L_2}{L_1}$, $\frac{L_2}{L_1} = \frac{1}{2}$

$L_1 = 2L_2$

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Q. The value of Planck's constant is 6.63×10^{-34} Js. The velocity of light is 3.0×10^{8} ms^{-1}. Which value is closest to the wavelength in nanometers of a quantum of light with frequency of 8×10^{15} s^{-1}?

A 4×10^{1}

B 3×10^{7}

C 2×10^{-25}

D 5×10^{-18}

$1\ nm = 10^{-9}\ m$

$1\ m = 10^{9}\ nm$

$\Rightarrow \nu = 8 \times 10^{15}$

$\Rightarrow \lambda = ?\ (nm)$

$\Rightarrow \nu = \frac{c}{\lambda}$

$$\lambda = \frac{c}{\nu} = \frac{3 \times 10^{8}\ \frac{m}{sec}}{8 \times 10^{15}\ \frac{1}{sec}}$$

$$= \frac{3}{8} \times 10^{-7}\ m = \frac{3}{8} \times 10^{-7} \times 10^{9}\ nm$$

$$4 \times 10^{1} \simeq \frac{30}{8} \times 10^{1}\ nm = \frac{3}{8} \times 10^{2}\ nm \simeq 4 \times 10^{1}\ nm$$

$C_{SD} = 7$

$$(\text{Energy})_{\text{before}} = (\text{Energy})_{\text{After}}$$

Energy value Constant rahegi

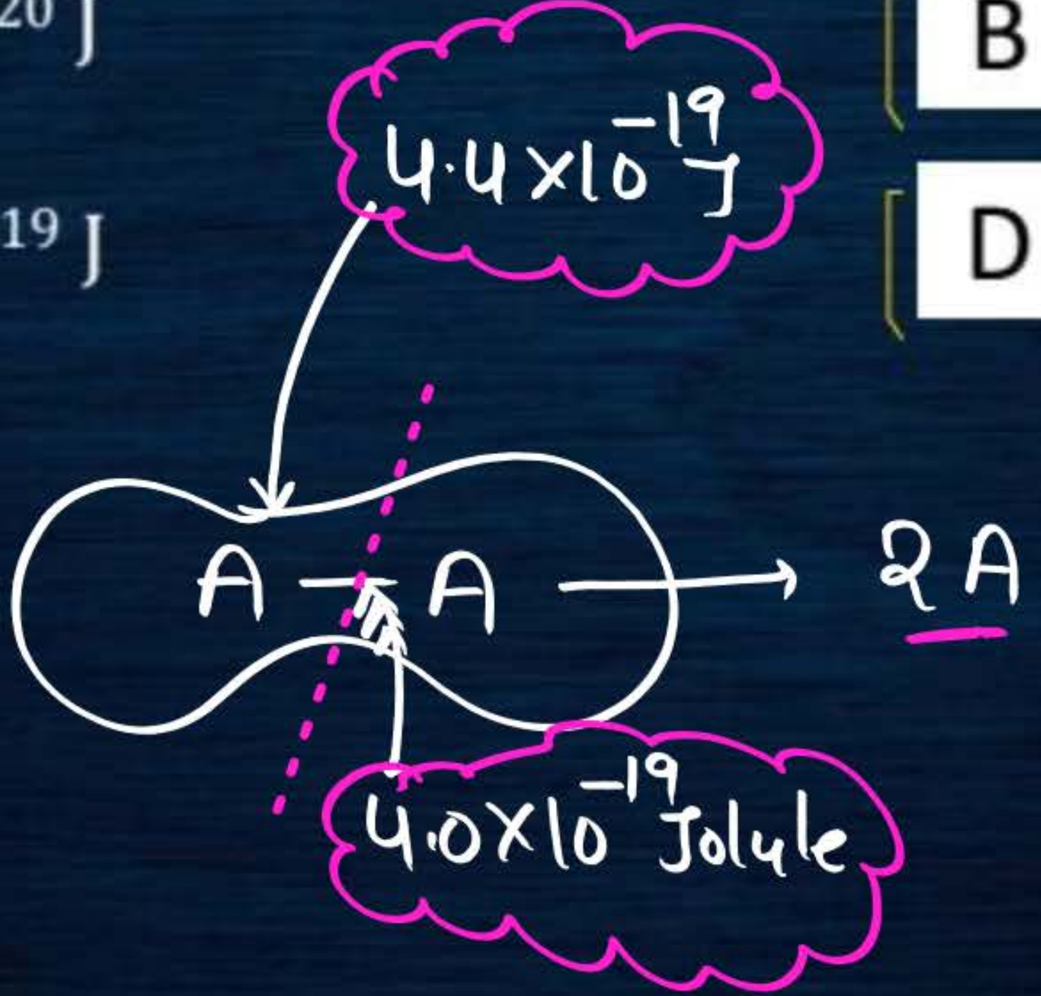
Q. The energy absorbed by each molecule (A_2) if a substance is 4.4×10^{-19} J and bond energy per molecule is 4.0×10^{-19} J. The kinetic energy of the molecule per atom will be

A. 2.0×10^{-20} J

B. 2.2×10^{-19} J

C. 2.0×10^{-19} J

D. 4.0×10^{-20} J



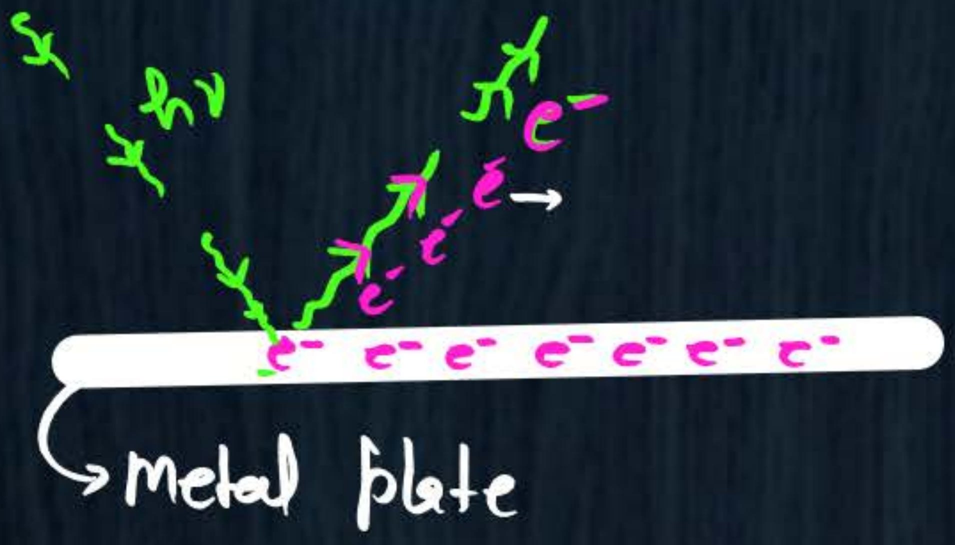
$K.E = 4.4 \times 10^{-19} - 4.0 \times 10^{-19}$

$K.E = 0.4 \times 10^{-19}$ Joule

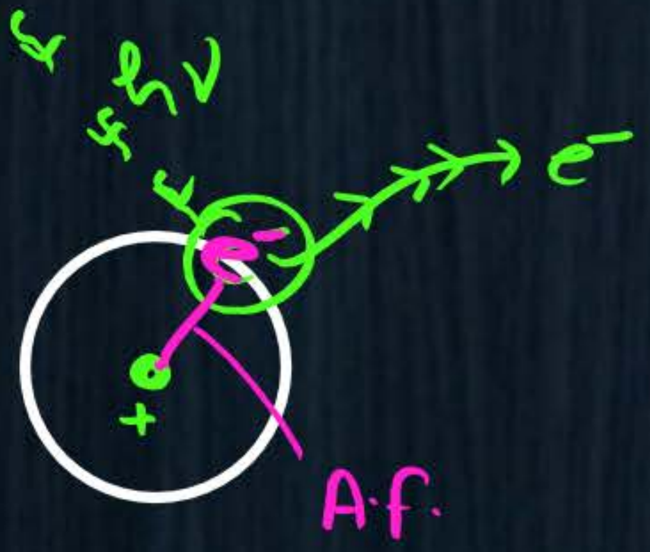
$K.E.\ \text{per atom} = \dfrac{0.4 \times 10^{-19}}{2} = 0.2 \times 10^{-19}$ Joule or 2×10^{-20} Joule

PHOTOELECTRIC EFFECT

→ Example of particle nature of light
(photon)



→ this phenomina is known as photo electric effect



→ It is surface phenomina

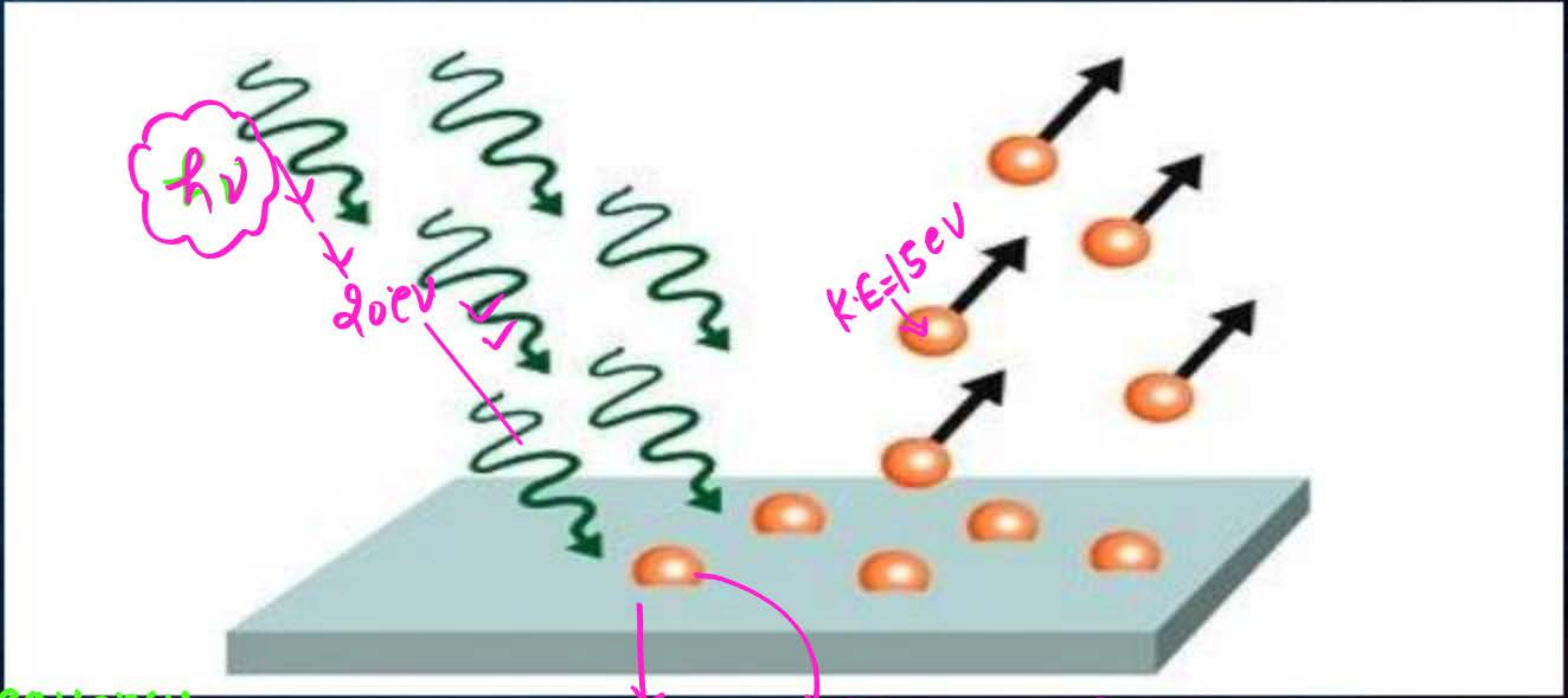
→ single photon emit always single electron

1 photon ⇒ 1 e^- nikalta hai

$h\nu = W_0 + K.E.$

$h\nu = h\nu_0 + \frac{1}{2}mu^2$

$W_0 = h\nu_0 + \frac{1}{2}mu^2$



ν_0 = threshold frequency
(min. frequency required to remove single e^- for metal plate)

(5eV) → W_0 = work function
(min. energy required to remove e^- in metal plate)

K.E. = Kinetic energy of e^-

u = velocity of electron
m = mass of electron

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$C_{SD} = 8$

① 1 photon = 1 $\bar{e}$ nikalta hai

② $h\nu = W_0 + K.E.$

③ $h\nu = h\nu_0 + \frac{1}{2}mu^2$

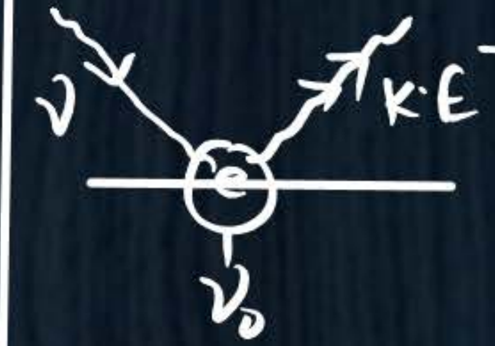
④ $\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + \frac{1}{2}mu^2$

W_0 = work funct^n

ν_0 = threshold frequency

λ_0 = threshold wavelength

Case→1 $\nu > \nu_0$ = $\bar{e}$ emitted with K.E.



→ $h\nu > W_0$

Case→2 ⇒ $\nu = \nu_0$ ⇒ $\bar{e}$ emitted with K.E = 0

→ $h\nu = W_0$

Case-3 $\nu < \nu_0$ ⇒ $\bar{e}$ not emit

→ $h\nu < W_0$

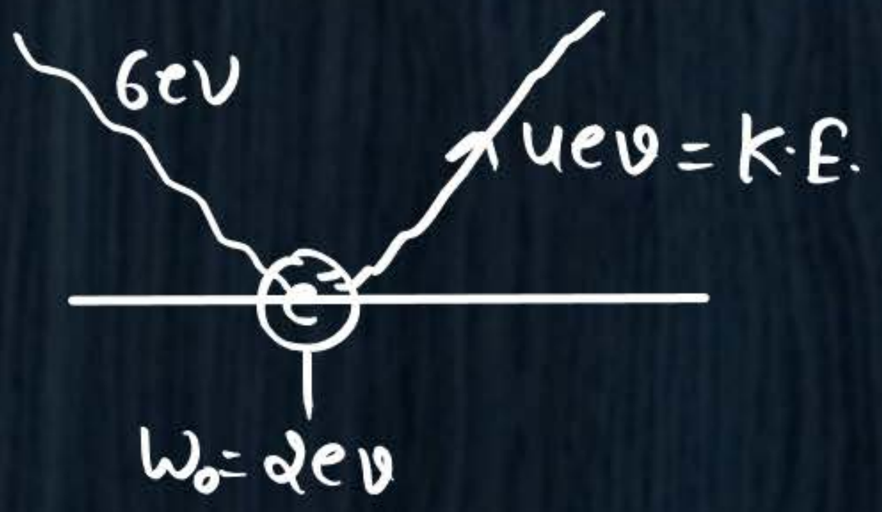
Q 6eV energy incident on the metal plate, If work function of metal plate is 2eV. How many electron emitted 25 Sec

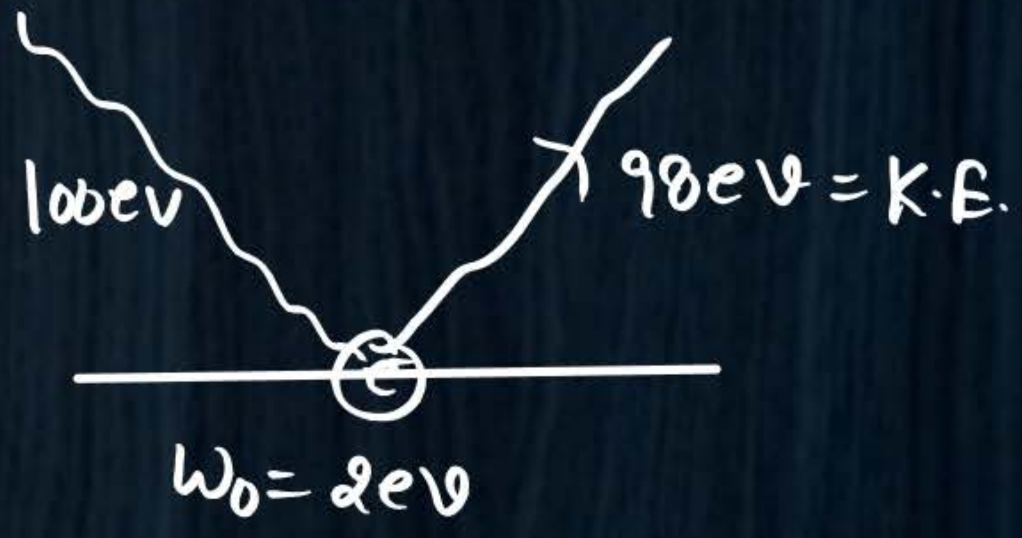
✓ (a) 1

(b) 2

(c) 3

(d) zero





Q 4 eV energy incident on the metal plate, If work function of metal plate is 3 eV select correct statements

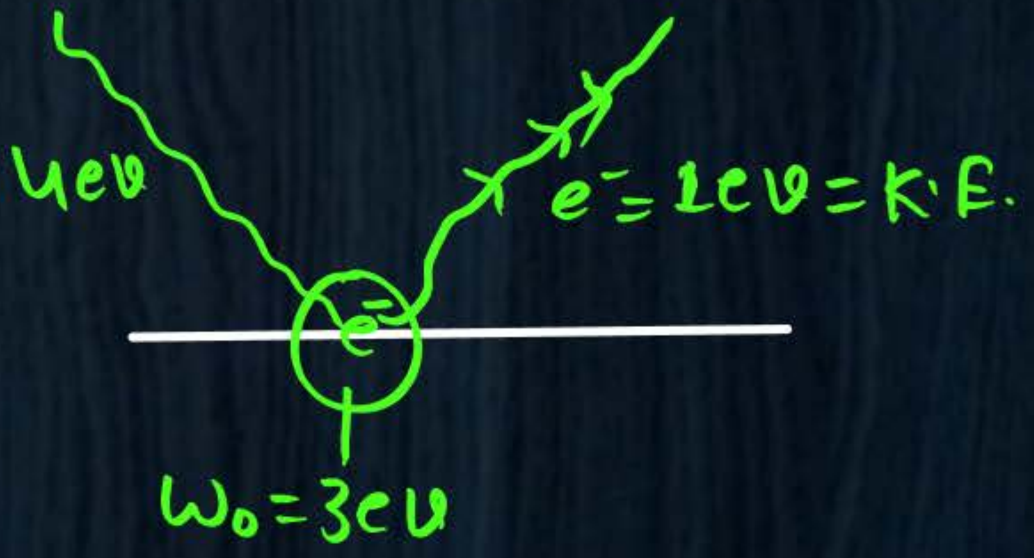
40 Sec

(a) e^- emitted with K.E. = 1 eV

(b) e^- emitted with K.E = 3 eV

(c) e^- emitted with K.E = 0

(d) e^- not emit



300 nm
or

Q 3000 $\mathring{A}$ wavelength photon incident on each metal plate

If work functⁿ of metal-A = 3 eV

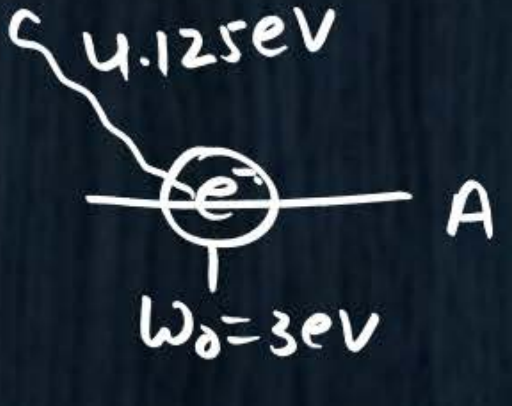
Work functⁿ of metal-B = 8 eV.

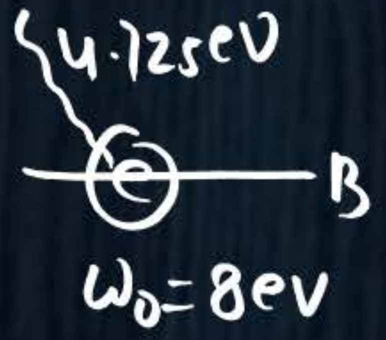
(a) ✓ A-plate emit e^-

(B) ✗ B-plate emit e^-

(c) ✗ A & B both plate emit e^-

(d) None of these





$(h\nu)_{photon} > W_0 \Rightarrow e^-$ emit

$(h\nu)_{photon} < W_0 = e^-$ is not emit.

Energy of photon $= \frac{hc}{\lambda}$

$= \frac{6.6\times10^{-34}\,J.sec \times 3\times10^{8}\,\frac{m}{sec}}{3000\times10^{-10}\,m}$

$= 6.6\times10^{-19}$ Joule

$= \frac{6.6\times10^{-19}}{1.6\times10^{-19}}\,eV = 4.125\,eV$

Q.

Integer Answer Type Questions :

The work function (ϕ) of some metals is listed below. The number of metals which will show photoelectric effect when light of 300 nm wavelength falls on the metal is ______.

or 3000 Å

Home work

Metal	Li	Na	K	Mg	Cu	Ag	Fe	Pt	W
Φ(eV)	2.4 ✓	2.3 ✓	2.2 ✓	3.7 ✓	4.8	4.3	4.7	6.3	4.75

IIT JEE Adv. [2011]

$h\nu = 4.125\ eV$

$h\nu > W_0$ → show photoelectric effect

(4)

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Q. In the photoelectron emission, the energy of the emitted electron is

A greater than the incident photon

B same as that of the incident photon

C smaller than the incident photon

D Proportional to the intensity of incident photon

Home work

Q. The work function of sodium metal is $4.41 \times 10^{-19}\ J$. If photons of wavelength $300\ nm$ are incident on the metal, the kinetic energy of the ejected electrons will be ______.

$[h = 6.63 \times 10^{-34}\ Js; c = 3 \times 10^{8}\ m/s]$ 222 $\times 10^{-21}\ J$. [2020 Main, 2 Sep. II]

W_0 $\frac{hc}{\lambda}$ K.E = ?

100 Sec = 2 minutes

eV → Joule

1 eV = 1.6×10^{-19} Jolule

Joule → eV jana ho = 1.6×10^{-19} divide krte hai.

$W_0 = 4.41 \times 10^{-19}\ J$

$$\frac{hc}{\lambda} = \frac{6.63 \times 10^{-34}\ Js \times 3 \times 10^{8}\ m/s}{300 \times 10^{-9}\ m}$$

$= 6.63 \times 10^{-19}$ Joule

$\frac{hc}{\lambda} = W_0 + K.E.$

$K.E = \frac{hc}{\lambda} - W_0 = 6.63 \times 10^{-19} - 4.41 \times 10^{-19}$

$= 2.22 \times 10^{-19}$ Joule

$= 222 \times 10^{-21}$ Joule

Q.

$W_0 = ?$

What is the work function of the metal, if the light of wavelength 400 Å generates photoelectron of velocity $6 \times 10^5\ ms^{-1}$ from it?

(Mass of electron = 9×10^{31} kg

Velocity of light = $3 \times 10^8\ ms^{-1}$

Planck's constant = 6.626×10^{-34} Js

Charge of electron = 1.6×10^{-19} Je V^{-1})

$\frac{hc}{\lambda}$ u   2 minutes

A 4.0 eV

B 2.1 eV

C 0.9 eV

D 3.1 eV

$$\frac{6.6 \times 10^{-34}\ J \times sec \times 3 \times 10^{8}\ \frac{m}{sec}}{400 \times 10^{-19}} = \frac{hc}{\lambda}$$

$$K.E. = \frac{1}{2} \times 9 \times 10^{31}\ kg \times (6 \times 10^{5})^2$$

$$\frac{hc}{\lambda} = W_0 + \frac{1}{2}mu^2$$

$$W_0 = \left(\frac{hc}{\lambda} - \frac{1}{2}mu^2\right) \text{Joule}$$

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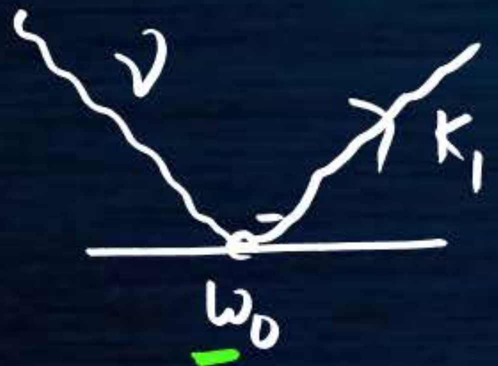
Q. When the frequency of light incident on a metallic plate is doubled, the KE of the emitted photoelectrons will be

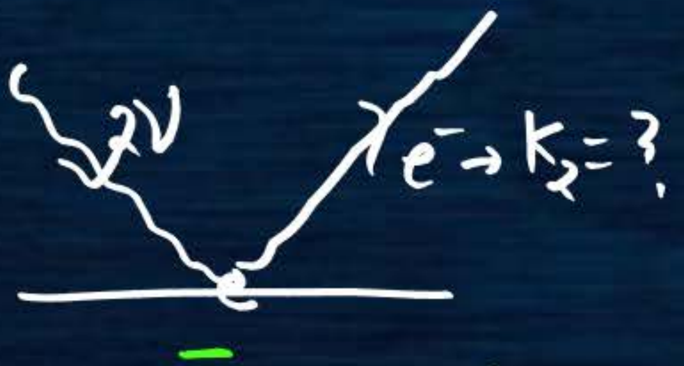
A doubled

B Doubled halved

C increased but more than double of the previous KE

D unchanged





$$h\nu = W_0 + K_1$$

$$2h\nu = W_0 + K_2$$

$$2(W_0 + K_1) = W_0 + K_2$$

$$2W_0 + 2K_1 = W_0 + K_2$$

$$W_0 + 2K_1 = K_2$$

$$K_2 = 2K_1 + W_0$$

$$K_2 > 2K_1$$

Home work

DPP-02 →

Thank - You